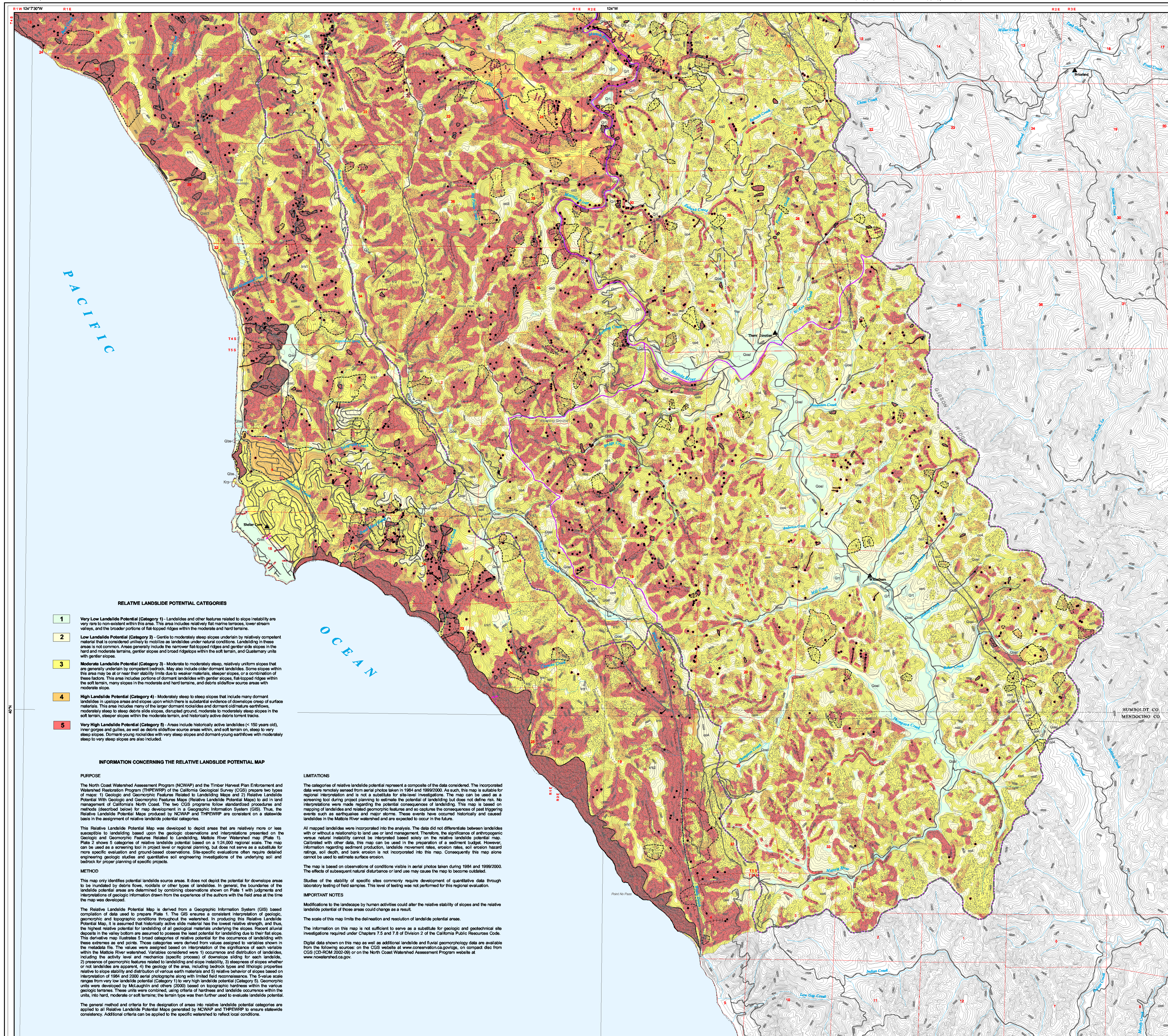

RELATIVE LANDSLIDE POTENTIAL WITH GEOLOGIC AND GEOMORPHIC FEATURES MATTOLE RIVER WATERSHED, HUMBOLDT AND MENDOCINO COUNTIES, CALIFORNIA PLATE 2, SHEET 3 OF 3 (SOUTHERN PORTION)

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RELATIVE LANDSLIDE POTENTIAL CATEGORIES

1 — **Very Low Landslide Potential (Category 1)** - Landslides and other features related to slope instability are very rare to non-existent within this area. This area includes relatively flat marine terraces, lower stream valleys, and the broader portions of flat-topped ridges within the moderate and hard terrains.

2 — **Low Landslide Potential (Category 2)** - Gentle to moderately steep slopes underlain by relatively competent material that is considered unlikely to mobilize as landslides under natural conditions. Landsliding in these areas is not common. Areas generally include the narrower flat-topped ridges and gentler side slopes in the hard and moderate terrains, gentler slopes and broad ridgetops within the soft terrain, and Quaternary units with gentler slopes.

3 — **Moderate Landslide Potential (Category 3)** - Moderate to moderately steep, relatively uniform slopes that are generally underlain by competent bedrock. May also include older dormant landslides. Some slopes within this area may be at or near their stability limits due to weaker materials, steeper slopes, or a combination of these factors. This area includes portions of dormant landslides with gentler slopes, flat-topped ridges within the soft terrain, many slopes in the moderate and hard terrains, and debris slide/flow source areas with moderate slope.

4 — **High Landslide Potential (Category 4)** - Moderately steep to steep slopes that include many dormant landslides in upslope areas and slopes upon which there is substantial evidence of downslope creep of surface materials. This area includes many of the larger dormant rockslides and dormant old/mature earthflows, moderately steep to steep debris slide slopes, disrupted ground, moderate to moderately steep slopes in the soft terrain, steeper slopes within the moderate terrain, and historically active debris torrent tracks.

5 — **Very High Landslide Potential (Category 5)** - Areas include historically active landslides (< 150 years old), inner gorges and gullies, as well as debris slide/flow source areas within, and soft terrain on, steep to very steep slopes. Dormant-young rockslides with very steep slopes and dormant-young earthflows with moderately steep to very steep slopes are also included.

INFORMATION CONCERNING THE RELATIVE LANDSLIDE POTENTIAL MAP

PURPOSE

The North Coast Watershed Assessment Program (NCWAP) and the Timber Harvest Plan Enforcement and Watershed Restoration Program (THPEWRP) of the California Geological Survey (CGS) prepare two types of maps: 1) Geologic and Geomorphic Features Related to Landsliding Maps and 2) Relative Landslide Potential With Geologic and Geomorphic Features Maps (Relative Landslide Potential Maps) to aid in land management of California's North Coast. The two CGS programs follow standardized procedures and methods (described below) for map development in a Geographic Information System (GIS). Thus, the Relative Landslide Potential Maps produced by NCWAP and THPEWRP are consistent on a statewide basis in the assignment of relative landslide potential categories.

This Relative Landslide Potential Map was developed to depict areas that are relatively more or less susceptible to landsliding based upon the geologic observations and interpretations presented on the Geologic and Geomorphic Features Related to Landsliding, Mattole River Watershed map (Plate 1). Plate 2 shows 5 categories of relative landslide potential based on a 1:24,000 regional scale. The map can be used as a screening tool in project level or regional planning, but does not serve as a substitute for more specific evaluation and ground-based observations. Site-specific evaluations often require detailed engineering geologic studies and quantitative soil engineering investigations of the underlying soil and bedrock for proper planning of specific projects.

METHOD

This map only identifies potential landslide source areas. It does not depict the potential for downslope areas to be inundated by debris flows, rockfalls or other types of landslides. In general, the boundaries of the landslide potential areas are determined by combining observations shown on Plate 1 with judgments and interpretations of geologic information drawn from the experience of the authors with the field area at the time the map was developed.

The Relative Landslide Potential Map is derived from a Geographic Information System (GIS) based compilation of data used to prepare Plate 1. The GIS ensures a consistent interpretation of geologic, geomorphic and topographic conditions throughout the watershed. In producing this Relative Landslide Potential Map, it is assumed that historically active slide material has the lowest relative strength, and thus, the highest relative potential for landsliding of all geological materials underlying the slopes. Recent alluvial deposits in the valley bottom are assumed to possess the least potential for landsliding due to their flat slope. This derivative map illustrates 5 broad categories of relative potential for the occurrence of landsliding with these extremes as end points. Those categories were derived from values assigned to variables shown in the metadata file. The values were assigned based on interpretation of the significance of each variable within the Mattole River watershed. Variables considered were 1) occurrence and distribution of landslides, including the activity level and mechanics (specific process) of downslope sliding for each landslide, 2) presence of geomorphic features related to landsliding and slope instability, 3) steepness of slopes whether or not landslides are apparent, 4) the geology of the area, including bedrock types and lithologic properties relative to slope stability and distribution of various earth materials and 5) relative behavior of slopes based on interpretation of 1984 and 2000 aerial photographs along with limited field reconnaissance. The 5-value scale ranges from very low landslide potential (Category 1) to very high landslide potential (Category 5). Geomorphic units were developed by McLaughlin and others (2000) based on topographic hardness within the various geologic terranes. These units were combined, using criteria of hardness and landslide occurrence within the units, into hard, moderate or soft terrains; the terrain type was then further used to evaluate landslide potential.

The general method and criteria for the designation of areas into relative landslide potential categories are applied to all Relative Landslide Potential Maps generated by NCWAP and THPEWRP to ensure statewide consistency. Additional criteria can be applied to the specific watershed to reflect local conditions.

LIMITATIONS

The categories of relative landslide potential represent a composite of the data considered. The incorporated data were remotely sensed from aerial photos taken in 1984 and 1999/2000. As such, this map is suitable for regional interpretation and is not a substitute for site-level investigations. The map can be used as a screening tool during project planning to estimate the potential of landsliding but does not define risk. No interpretations were made regarding the potential consequences of landsliding. This map is based on mapping of landslides and related geomorphic features and so captures the consequences of past triggering events such as earthquakes and major storms. These events have occurred historically and caused landslides in the Mattole River watershed and are expected to occur in the future.

All mapped landslides were incorporated into the analysis. The data did not differentiate between landslides with or without a relationship to land use or land management. Therefore, the significance of anthropogenic versus natural instability cannot be interpreted based solely on the relative landslide potential map. Calibrated with other data, this map can be used in the preparation of a sediment budget. However, information regarding sediment production, landslide movement rates, erosion rates, soil erosion hazard ratings, soil depth, and bank erosion is not incorporated into this map. Consequently this map alone cannot be used to estimate surface erosion.

The map is based on observations of conditions visible in aerial photos taken during 1984 and 1999/2000. The effects of subsequent natural disturbance or land use may cause the map to become outdated.

Studies of the stability of specific sites commonly require development of quantitative data through laboratory testing of field samples. This level of testing was not performed for this regional evaluation.

IMPORTANT NOTES

Modifications to the landscape by human activities could alter the relative stability of slopes and the relative landslide potential of those areas could change as a result.

The scale of this map limits the delineation and resolution of landslide potential areas.

The information on this map is not sufficient to serve as a substitute for geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the California Public Resources Code.

Digital data shown on this map as well as additional landslide and fluvial geomorphology data are available from the following sources: on the CGS website at www.conservation.ca.gov/cgs, on compact disc from CGS (CD-ROM 2002-09) or on the North Coast Watershed Assessment Program website at www.ncwatershed.ca.gov.

MAP UNITS

QUATERNARY AND LATE TERTIARY OVERLAP DEPOSITS

- **Qscu** — **Undifferentiated Stream Channel Deposits (Holocene)** - Unconsolidated sediments in active channels and flood plains.
- **Qbs** — **Beach Sand (Holocene)** - Marine-laid deposits of fine- to coarse-grained sand and gravel; may migrate seasonally.
- **Qds** — **Aeolian deposits (Holocene)** - Unconsolidated fine- to medium-grained, well-sorted sand.
- **Qf** — **Alluvial fan (Holocene)** - Characteristic fan-cone shapes at the mouths of eroding stream canyons; includes debris fans.
- **Qal** — **Alluvium (Holocene and Late Pleistocene?)** - Undifferentiated alluvial deposits of unconsolidated sand, gravel, silt, and lesser clay.
- **Qc** — **Colluvium (Holocene-Pleistocene)** - Talus and slope wash deposits.
- **Qoal** — **Older alluvium (Early Holocene and Pleistocene)** - Unconsolidated to weakly consolidated alluvial deposits above the active channel in broader canyons and valleys; vegetation is characteristically well-established.
- **Qrt** — **River terrace deposits (Holocene and Pleistocene)** - Dominantly sand and gravel with lesser silt and clay deposited during higher stream stands over flat-lying to gently inclined platforms.
- **Qmt** — **Marine terrace deposits (Quaternary)** - Sand and gravel deposited in a shallow marine setting on gently inclined wave-cut beaches.
- **Qt** — **Undifferentiated terrace deposits (Quaternary)** - Alluvial and/or (near the coast) shallow marine deposits preserved in erosional remnants of older platforms well above present stream level.
- **QTw** — **Overlap Deposits (Neogene)** - Wildcat Group-equivalent rocks; weakly lithified sandstone, mudstone, and minor conglomerate.

FRANCISCAN COMPLEX*
Coastal Belt
Coastal Terrane (Pliocene to Late Cretaceous)

- **co1** — **Melange** - Dominantly highly folded argillite and highly clayey, penetratively sheared rock that exhibits rounded, lumpy, and irregular, poorly incised topography.
- **co2** — **Melange** - Subequal amounts of shattered sandstone and argillite with much clayey, penetratively sheared rock that exhibits generally irregular topography lacking well-incised sidehill drainages.
- **co3** — **Broken sandstone and argillite** - Exhibits sharp-crested topography with a well-incised system of sidehill drainage.
- **co4** — **Intact sandstone and argillite** - Exhibits sharp-crested topography with a regular, well-incised system of sidehill drainage.
- **cob** — **Basaltic rocks (Late Cretaceous)** - Pillow flows, tuffs, flow breccias, and intrusives present as rare blocks in melange.
- **cols** — **Limestone (Late Cretaceous)** - Pink to red, manganiferous, and containing pelagic foraminifers.
- **m** — **Blueschist (Jurassic?)**

King Range Terrane (Miocene to Late Cretaceous)

- **Krp** — **Igneous and sedimentary rocks of Point Delgada (Late Cretaceous)** - Basaltic rocks, sandstone, minor argillite, and melange containing rare blueschist blocks.
- **krk1** — **Melange and (or) folded argillite of King Peak** - Thin-bedded, highly folded, predominantly argillitic sequences that exhibit subdued, irregular topography lacking a well-incised system of sidehill drainages.
- **krk2** — **Highly folded, broken formation of King Peak** -Thick- to thin-bedded arkosic sandstone and calcareous argillite that exhibit sharp-crested topography with well incised but irregular sidehill drainages.
- **krk3** — **Highly folded, largely unbroken rocks of King Peak** - Sandstone and argillite that exhibit sharp-crested topography with a regular, well-incised system of sidehill drainages.
- **krl** — **Limestone** - Red to white, locally with planktic or benthic foraminifers; present locally as melange blocks, and as interbeds in calcareous argillite.
- **krc** — **Chert** - Red to green, locally manganiferous, with radiolaria and diatoms.
- **krb** — **Basaltic rocks** - Tholeiitic and alkalic, present as rare blocks in melange.

Yager Terrane (Eocene to Paleocene)

- **y1** — **Sheared and highly folded mudstone** - Includes minor rhythmically interbedded sandstone, locally with lenses of conglomerate. Exhibits irregular topography lacking a well-incised system of sidehill drainages.
- **y2** — **Highly folded, broken mudstone, sandstone, and conglomeratic sandstone** - Exhibits topography with sharp ridge-crests and well-incised sidehill drainages.
- **y3** — **Highly folded, little-broken sandstone, conglomerate, and mudstone** - Exhibits sharp-crested topography with a regular, well-incised system of sidehill drainages.
- **Ycgl** — **Conglomerate** - Polymict, well-rounded clasts that include volcanic, granitic, and less common metaclastic rocks.

Central Belt (Paleocene? to Jurassic)

- **cm1** — **Melange** - Predominantly penetratively sheared, locally tuffaceous, scaly meta-argillite and less abundant blocks of metasandstone.
- **cb1** — **Broken formation** - Bedded to massive, locally folded, rarely conglomeratic metasandstone and meta-argillite, with minor highly sheared rocks.
- **cwr** — **White Rock metasandstone (Paleocene and/or Late Cretaceous)** - Arkosic metasandstone and minor meta-argillite, thick-bedded to massive, shattered and sheared.
- **cls** — **Limestone (Late to Early Cretaceous)** - Red, pink, gray, or white foraminiferal limestone.
- **bs** — **Basaltic rocks (Cretaceous and Jurassic)** - Includes pillowed and non-pillowed flows, flow breccias, submarine tuff, and diabase.
- **b** — **Melange block** - Lithology unknown.
- **sp** — **Serpentinite** - Interleaved locally along faults.

* Franciscan Complex subdivisions from McLaughlin and others, 2000

MAP SYMBOLS

Lithologic contact: Solid where location is certain, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain.

Fault: Solid where location is certain, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain.

Thrust fault: Solid where location is certain, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain.

Lineament: Linear feature of unknown origin noted on aerial photographs.

Anticline: Solid where location is certain, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain.

Syncline: Solid where location is certain, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain.

Watershed boundary
Subbasin boundary
County boundary
Public Land Survey System
Stream
Road, street or trail
City or town

ROCK SLIDE (ROTATIONAL / TRANSLATIONAL LANDSLIDE): Slope movement with bedrock as its primary source material. This class of failure includes rotational and translational landslides; relatively cohesive slide masses with failure planes that are deep-seated in comparison to those debris slides of similar areal extent. The slide plane is curved in a rotational slide. Movement along a planar joint or bedding surface may be referred to as translational. Complex versions with combinations of rotational heads and translational movement or earthflows downslope are common. indicates a scarp; arrows show direction of movement; queried where the presence of the slide is uncertain. Boundary is solid where historically active, dashed where dormant, queried where uncertain.

EARTHFLOW: Slow to rapid movement of mostly fine-grained soil with some rocky debris in a semi-viscous, highly plastic state. After initial failure, the mass may flow or creep seasonally in response to changes in groundwater level. These types of slope failures often include complexes of nested rotational slides and deeply incised gullies. Boundaries are usually indistinct. indicates a scarp; arrow indicates direction of movement. Queried where the presence of the slide is uncertain. Boundary is solid where historically active, dashed where dormant, queried where uncertain.

DEBRIS SLIDE: Mass of unconsolidated rock, colluvium, and coarse-grained soil that has moved slowly to rapidly downslope along a relatively steep, shallow, translational failure plane. Debris slides form steep, unvegetated scars in the head region and possibly irregular, hummocky deposits in the toe region. Scars commonly ravel and remain unvegetated for several seasons depending on slope aspect. Queried where the presence of the slide is uncertain. Boundary is solid where historically active, queried where uncertain.

DEBRIS FLOW / TORRENT TRACK: Long stretches of bare ground that have been scoured and eroded to bedrock by extremely rapid movement of water-laden debris. Debris flows are commonly triggered by debris sliding in the source area during high intensity rains. Debris is often deposited downslope as a tangled mass of organic material in a matrix of rock and soil; debris may be reworked and incorporated into subsequent events; lack of vegetation indicates recent activity. Queried where the presence of the slide is uncertain. Boundary is solid where historically active, dashed where dormant, queried where uncertain.

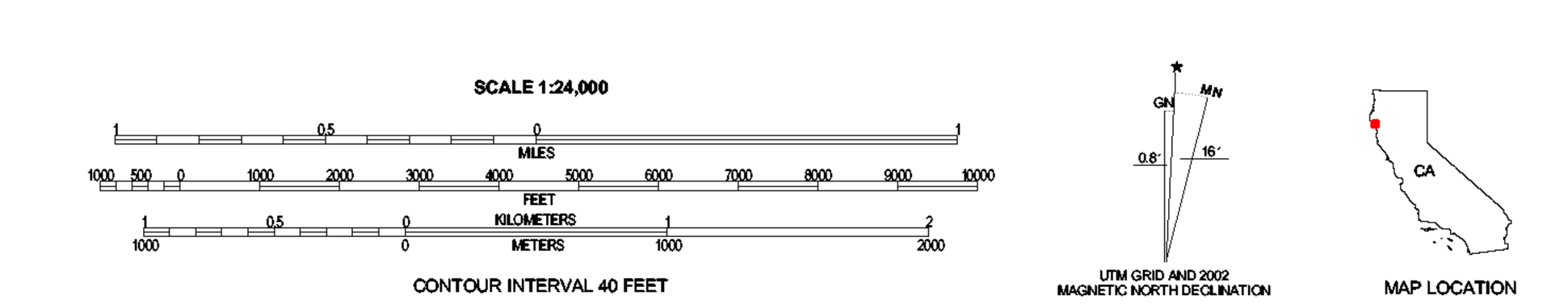
SMALL LANDSLIDE: Landslide too small to delineate at 1:24,000 scale (typically less than 1/5 acre in area or less than 150 feet in length).

DISRUPTED GROUND: Irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at 1:24,000 scale; also may include areas affected by downslope creep, expansive soils, and/or gully erosion. Boundaries are usually indistinct.

DEBRIS SLIDE SLOPE / SOURCE AREA: A geomorphic feature characterized by steep, usually well vegetated slopes that appear to have been sculpted by numerous debris slides and debris flows. Upper reaches (source areas) of these slopes are often tightly concave and very steep. Soil and colluvium atop bedrock may be disrupted by active debris slides and debris flows. Slopes near the angle of repose may be relatively stable except where weak bedding planes, bedrock joints and fractures parallel the slope.

INNER GORGE: A geomorphic feature consisting of steep slopes adjacent to channels. The gorge typically is created by accelerated downcutting in response to regional uplift. It is defined as an area of streambank between the channel and the first break in slope. Line is queried where uncertain, or broken into segments to represent a stretch of discontinuous inner gorge too small to accurately represent at 1:24,000 scale. One-sided hachures indicate inner gorge on one side of channel only; hachures point downslope.

GULLY: Distinct, narrow channel formed by erosion of soil or soft rock material by running water. Channels are larger and deeper than rills and usually carry water only during and immediately after heavy rain or following the melting of ice or snow. Arrows point downhill; line is queried where uncertain.



GEOLOGICAL NOTES

1) The landslides and geomorphic features were mapped from 1984 WAC aerial photographs, nominal scale 1:31,680, and 2000 WAC aerial photographs, nominal scale 1:24,000. Field verification of landslide and geomorphic features was very limited and mapping relied primarily on interpretation of aerial photographs.

2) The geology depicted on this map was modified from 1:100,000-scale source data (McLaughlin and others, 2000). Although the geology has been presented on this map at a scale of 1:24,000, the detail and accuracy of the bedrock and structural data are limited to the spatial resolution of the 1:100,000 scale in which the digital database was originally compiled.

3) Please see geologic report for full lithologic descriptions, geologic setting, methodologies and limitations.

4) Landslides shown on this map have been divided into groups based on the clarity of their morphology and inferred type of movement. The landslides are also classified according to the certainty of their existence as determined by analysis of aerial photographs. The various landslide designations are not intended to, nor should they be interpreted to imply, the relative stability of slopes involved. Please see Plate 2 for relative landslide potential of the study area.

5) The scale of this map limits the delineation of some features, and the map should not be substituted for site-specific studies.

6) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the California Public Resources Code.

7) Historical mapping by CGS (Spittler, 1983 and 1984; DMG, 1999) was considered and incorporated using current interpretive protocols for identifying and classifying geomorphic features and/or landslides. Historical mapping added directly to the Mattole River Watershed database is referenced in the electronic database with a citation to the North Coast Watersheds Mapping, digital compilation DMG CD 99-002 (DMG, 1999).

8) All small landslides (depicted on the map as points) inferred from review of the 1984 and 2000 aerial photograph sets and those mapped on CGS Open-File Reports (Spittler, 1983 and 1984) are shown on the map.

9) Digital data shown on this map as well as additional landslide and fluvial geomorphology data are available from the following sources: on the CGS website at www.conservation.ca.gov/cgs, on compact disc from CGS (CD-ROM 2002-09), or on the North Coast Watershed Assessment Program website at www.ncwatershed.ca.gov.

REFERENCES

California Division of Mines and Geology, 1999, North Coast Watersheds mapping, digital compilation DMG CD 99-002, California Department of Conservation, Division of Mines and Geology.

McLaughlin, R.J., Ellen, S.D., Blake, M.C., Jr., Jayko, A.S., Irwin, W.P., Aalto, K.R., Carver, G.A. and Clarke, S.H., Jr., 2000, Geology of the Cape Mendocino, Eureka, Garberville and southwestern part of the Hayfork 30 x 60 minute quadrangles and adjacent offshore area, northern California, U.S. Geological Survey Miscellaneous Field Studies MF-2336, scale 1:100,000, 25 p. with digital data.

Spittler, T.E., 1984, Geology and geomorphic features related to landsliding, Briceland, Buckeye Mountain, Capetown, Honeydew, and Taylor Peak 7.5' quadrangles, Humboldt County, California: California Division of Mines and Geology Open-File Reports 84-10, 84-37, 84-34, 84-11, and 84-36, respectively, scale 1:24,000.

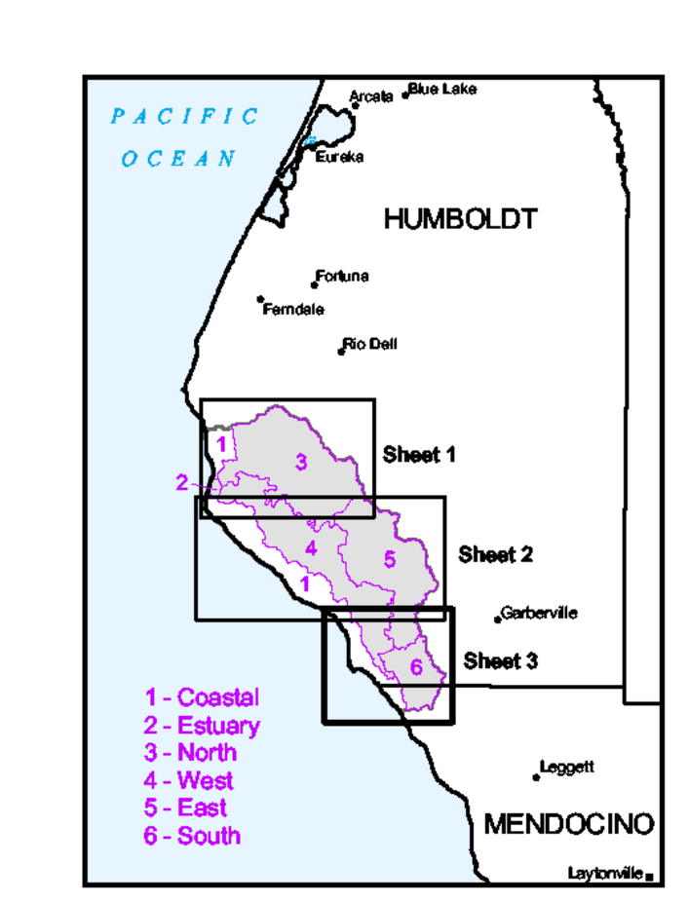
Spittler, T.E., 1983, Geology and geomorphic features related to landsliding, Bull Creek and Weott 7.5' quadrangles, Humboldt County, California: California Division of Mines and Geology, Open-File Reports 83-3 and 83-6, respectively, scale 1:24,000.

MATTOLE AERIAL PHOTOGRAPHS BY YEAR

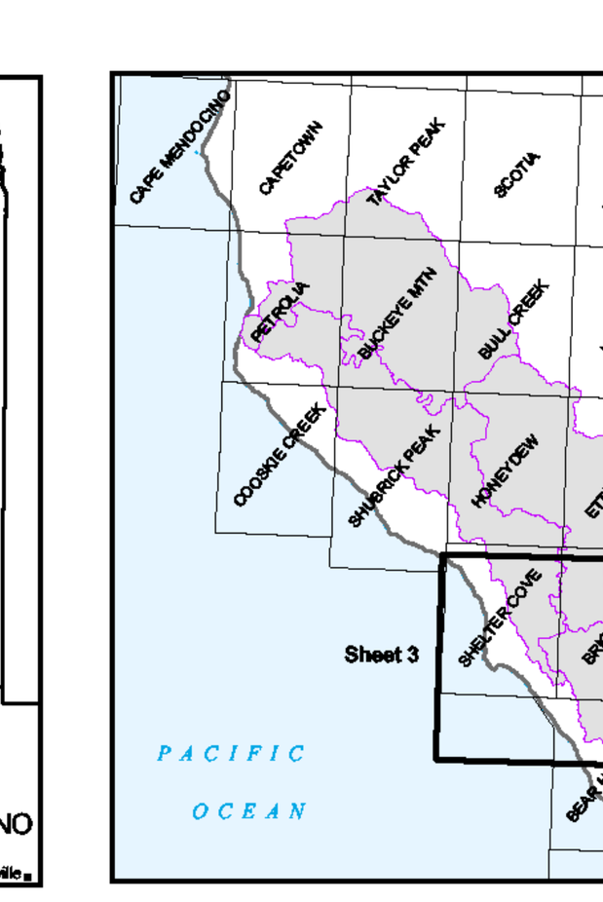
WAC Corporation, Inc., 2000, Flight WAC-00-CA: roll 4, frames 1-15, 83-96, 164-167 and 173-175; roll 6, frames 1-21 and 95-113; roll 7, frames 1-15, 48-63, 88-104, 135-148, 165-177, 191-201 and 213-219; roll 9, frames 176-191; black and white, vertical, nominal scale 1:24,000, dated 3-31-00.

WAC Corporation, Inc., 2000, Flight WAC-00-CA: roll 10, frames 64-67, 70-75 and 77-81; black and white, vertical, nominal scale 1:24,000, dated 3-31-00.

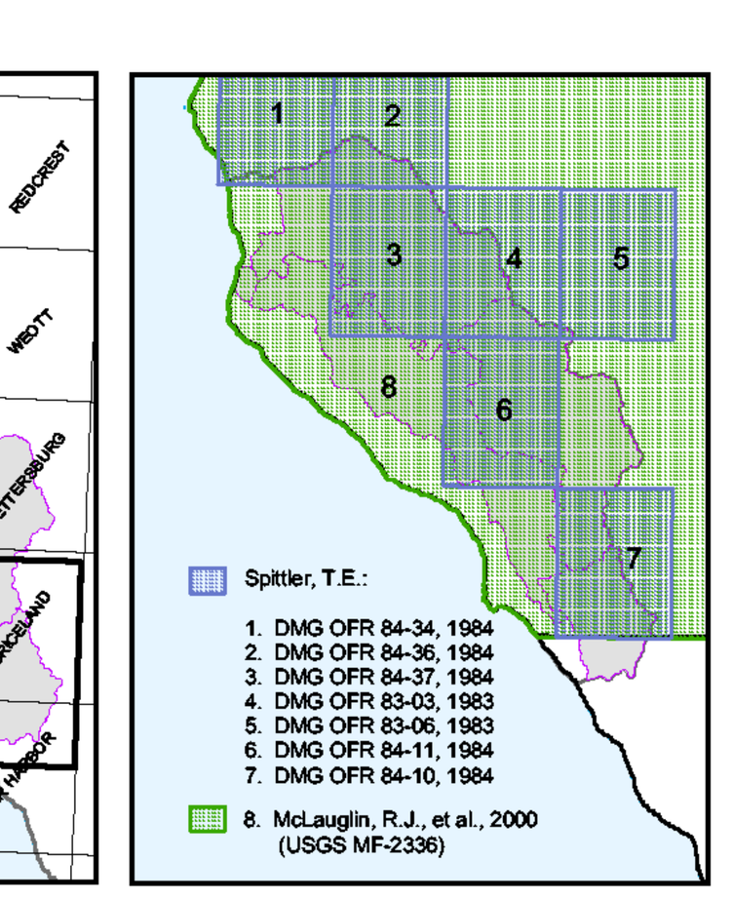
WAC Corporation, Inc., 1984, Flight WAC-84C: roll 21, frames 42-54, 95-109, 131-142, 161-169, 185-193 and 203-217; roll 24, frames 64-78 and 160-171; roll 25, frames 75-85; black and white, vertical, nominal scale 1:31,680, dated 5-6-84.



INDEX TO SUBBASINS



INDEX TO USGS 7.5' QUADRANGLES



INDEX TO GEOLOGIC AND GEOMORPHIC MAPPING REFERENCES

North American Datum of 1983 (NAD83)
Projection: Universal Transverse Mercator, Zone 10

DATA SOURCES

Watershed boundaries	1:24,000 California Watershed Map (CALWATER v.2.2a)
Hydrography	1:24,000 USGS DLG
Transportation	1:24,000 USGS DLG
Hypsography	1:24,000 USGS DLG
Public Land Survey System	1:100,000 USGS DLG
County boundaries	1:100,000 USGS DLG

www.conservation.ca.gov/cgs

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